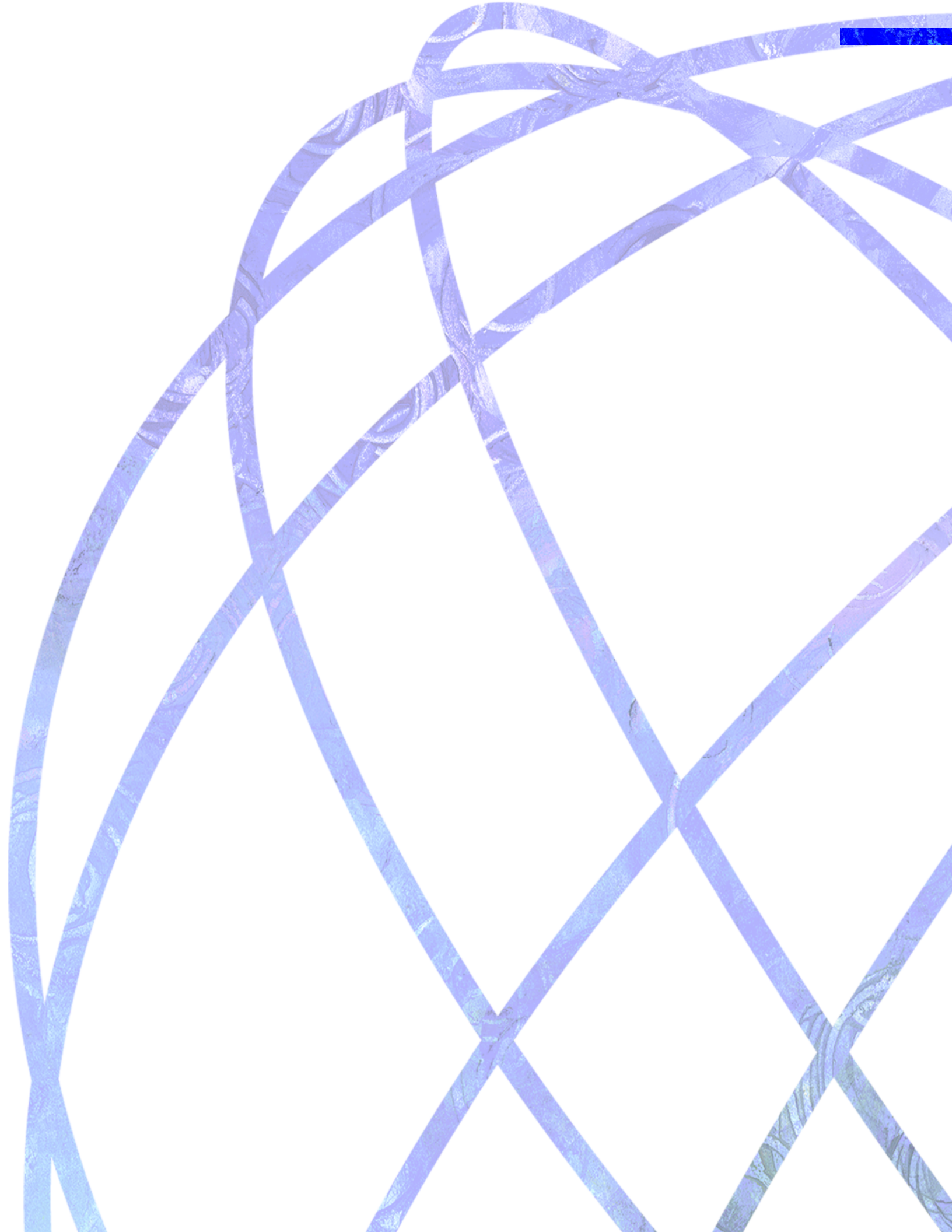# The Freight Technology Story

Intelligent Freight Technologies and Their Benefits

This report discusses advancements in information technologies and telecommunications that have improved the efficiency, reliability, and security of freight transportation and increased global connectivity. It also describes how these technologies work and the benefits they deliver, including the results from intelligent freight technology field operational tests (FOTs) and other initiatives.

THE INNOVATION AND IMPLEMENTATION PROCESS

Successful technology innovations follow a four-step process: (1) A *bright idea* that sets the stage for (2) *tests and demonstrations*. Successful results and a strong business case then combine to move market leaders to (3) *initial adoption and deployment*. Once the viability of a new technology is well established and its benefits are clear, (4) *wide adoption* will occur. Step 4 cements the transition of the bright idea to market penetration. However, the biggest hurdle in the process is building sufficient confidence in the technology, through tests and demonstrations, to prompt initial adoption—the move to step 3.

Three principal triggers move businesses to implement intelligent freight technologies:

1. **Pursuit of competitive advantage** is likely to be the main trigger for market leaders and innovators as they seek to improve their firm's standing and profitability in the marketplace. The critical element is a credible business plan.

2. **Keeping up with competitors** is the apparent catalyst for market followers. Success by market leaders progressively erases doubt and skepticism about new solutions and shifts the debate in other firms from *whether* to *when and how*.

3. **Compliance** may arise from customer demands or government regulations. Commercial compliance comes into play when customers demand innovation as a condition of doing business. Regulatory compliance is self explanatory.

There are also several barriers to the acceptance of new technologies and operating practices:

- Skepticism about **efficacy** **is** the fundamental concern.
- Immature **standards** can deprive vendors and users of a common and fair template for deployment.
- Concerns about **negative operational impacts**, such as the need to replace batteries in the field, may mobilize opposition from service providers.
- The **credibility of the business case** is often the dominant concern, with the strongest skepticism reserved for estimates of benefits.
- **Exposure to government actions** or inaction adds barriers to some intelligent freight projects that depend on government funding to deploy common infrastructure or affects decisions on which path to take.
- Concerns about the loss of **proprietary information** may keep some firms from committing to new technologies and networks.

THE REACH OF INTELLIGENT FREIGHT TECHNOLOGIES

Intelligent freight technologies monitor and manage physical assets and information flows. Five clusters of technologies can be applied individually or in tailored combinations:

- **Asset tracking** uses mobile communications, radio frequency identification (RFID), and other tools to monitor the location and status of tractors, trailers, chassis, containers and, in some cases, cargo.
- **On-board status monitoring** uses sensors to monitor vehicle operating parameters, cargo condition, and attempts to tamper with the load.
- **Gateway facilitation** uses RFID, smart cards, weigh-in-motion, and non-intrusive inspection technologies to simplify and speed operations at terminal gates, highway inspection stations, and border crossings.
- **Freight status information** uses web-based technologies and standards to facilitate the exchange of information related to freight flows.

• **Network status information** uses services to integrate data from cameras and road sensors and uses display technologies to monitor congestion, weather conditions, and incidents.

The U.S. Department of Transportation (DOT) began its FOT program in the late 1990s, using public/private cost sharing and formal independent assessments to test high-potential combinations of intelligent freight technologies. *The Freight Technology Story* integrates information from all six DOT field operational test programs and also pulls together the highlights of several non-DOT field test programs.

U.S. DEPARTMENT OF TRANSPORTATION ITS FIELD OPERATIONAL TESTS

Test	What It Tests
Electronic Supply Chain Manifest	Smart cards, biometrics, and electronic manifesting for air freight terminal access
Pacific Northwest FOTs	Electronic seals, truck transponders, web-based tracking
Freight Information Real-Time System for Transport	Electronic tracking of chassis and containers and web-based port info system
Cargo*Mate	Wide-area chassis tracking and e-seal integration
Freight Information Highway and Chassis Tracking	Web portal data exchange and wide-area chassis tracking
Hazardous Materials Safety and Security	Tests of multiple technologies including asset tracking to monitor four types of hazmat shipments and show improvements in safety and security

INTELLIGENT FREIGHT TECHNOLOGY BENEFITS

Successful deployments of intelligent freight technologies yield three types of bene-fits: 1) private sector, 2) public sector, and 3) freight network.

Private Sector Benefits

Increases in efficiency and productivity are key private-sector benefits that can be measured with relative ease. The Hazardous Materials (Hazmat) Safety and Security FOT reported asset-tracking savings ranging from $7,866 to $15,222 per tractor per year. The Electronic Supply Chain Manifest (ESCM) FOT evaluators documented up to $16.20 in savings per airfreight shipment from faster manifest preparation and security processing. The Cargo*Mate evaluation estimated annual benefits to carriers of $210.35 per container chassis. This class of benefits enables operators to deliver a given level of service with fewer resources.

Improved reliability and service are other private-sector benefits that help users of freight transportation services. Better schedule adherence, speed, and operational flexibility translate into inventory management and customer service-related benefits. Two small tests outside the DOT FOT program—the U.S. Trade Development Agency's Bangkok Efficient and Secure Trade project and the industry-funded Smart and Secure Tradelanes initiative—reported about $400 per container in benefits to shippers from better asset tracking.

The private sector also benefits from **enhanced shipment and service integrity**, which apply to both freight system users and providers. A dray operator in the Cargo*Mate FOT captured a "pre-9/11" benefit related to potential equipment abuse when missing chassis dropped from four percent of the fleet to zero.

Public Sector Benefits

By smoothing traffic flows around major freight hubs, intelligent freight technologies can deliver tangible **environmental and quality-of-life** benefits and help **increase the**

effective capacity of transportation infrastructure. Public agencies also derive direct efficiency and productivity benefits from successful deployments. For example, state highway enforcement agencies can increase the number of trucks that an inspector processes in an hour, and Customs officials can screen more inbound containers and cross-border trailers. Successful deployment of these technologies can yield significant safety benefits as well. Some technologies permit agencies to focus their enforcement attention on problem areas, yielding proportionally greater benefits. On-board vehicle sensors may reduce the number of incidents by calling attention to defective brakes or tires. The Hazmat FOT also reported better emergency response, as evaluators found that rapid notification of incidents could lower environmental mitigation costs and potential public exposure to these releases. Finally, the public sector could benefit from intelligent freight technologies in the area of national security. To the degree intelligent freight technologies enhance security against terrorism, they contribute to the society as a whole.

Freight Network Benefits

Freight network benefits are qualitatively different than the intelligent freight technology benefits discussed above; the focus shifts from results achieved by individual firms and projects to large-scale system impacts. Higher quality, lower cost transportation services deliver the most important network benefits when they affect other industries and, through them, the economy as a whole.

The key to realizing network benefits is to enable industries that depend on freight transportation to produce the same amount of goods and services for less. In response to freight transportation improvements, industries can change how much it costs to produce goods from the input cost of raw materials to the cost of finished product delivery. Better freight networks can stimulate advantageous shifts in demand and supply curves for goods and services—an improved freight network thus generates economic growth and greater prosperity. Recent history illustrates the potential value of such shifts: since 1980, transportation and logistics improvements freed up

seven percent of the U.S. Gross Domestic Product—a benefit worth about $650 billion to the economy in 2003 alone.

RESULTS AND CONCLUSIONS

The discussion of triggers and barriers suggests that a credible business case is the single most important hurdle to clear in deciding to implement a new technology. When market leaders pursue competitive advantage to enhance profitability, a strong business case is a potent trigger for action. However, market followers will not embrace and expand the use of new technologies unless market leaders and innovators demonstrate marked success.

This report and the FOT results show there are gains to be made from the use of intelligent freight technologies, not only for the private and public sectors, but also for the economy as a whole. To the degree these technologies expand the effective capacity of our transportation system and firms succeed in using the technologies to capture efficiencies, improve reliability, and enhance shipment integrity, freight network benefits are expected to kick in, boosting national productivity and prosperity.

Technology trends are moving in the right direction, but there are barriers that work against implementation. The challenge is to accelerate progress—not rush, but accelerate—and thus increase the present value of intelligent freight benefits for firms and for the economy.

INTRODUCTION

The freight industry and its customers use information techologies and telecommunications to improve freight system efficiency and productivity, increase global connectivity, and enhance freight system security against common threats and terrorism. In short, these technologies help us operate the transportation system more intelligently. Most importantly, they do so in ways that improve safety, whether related to hazardous materials transport, heavy truck maintenance, or load limit compliance.

The U.S. Department of Transportation's (DOT's) Federal Highway Administration (FHWA) and Joint Program Office (JPO) work collaboratively with private industry to identify technologies that meet common goals and support their testing and evaluation in the field. Independent evaluation of technology performance, costs, and benefits is a key part of DOT's efforts. FHWA and JPO also publish information and sponsor workshops, forums, and groups, such as the Intermodal Freight Technology Working Group, to encourage widespread information exchange on freight technologies.

Intelligent freight technologies are currently deployed in several areas:

- Asset tracking: Mobile communications and global positioning systems, bar codes, and radio frequency identification (RFID) tags track the location of trucks, containers, and cargo to improve efficiency and to ensure the safety and security of shipments.

- On-board status monitoring: Sensors record vehicle operating conditions, check the condition of cargo, and detect tampering or intrusion.

- Gateway facilitation: Non-intrusive inspection technologies, such as scanners and RFID tags, are used at terminals, inspection stations, and border crossings to search for contraband and enhance national security.

- Freight status information: Web-based technologies facilitate the exchange of information on freight shipments and improve data flows.

• **Network status information:** Cameras, road-sensors, and display technologies monitor congestion, weather conditions, and incidents.

The Freight Technology Story provides information about the state of the art and the adoption of effective technologies by the freight industry and its customers. Specifically, this report discusses:

• innovation and implementation processes for intelligent freight technologies;
• triggers for and barriers to deployment;
• the five types of intelligent freight technologies and related operational tests;
• private, public, and network-based benefits of using these technologies; and
• business case perspectives and operational test results.

The appendix provides an annotated list of references and points of contact for more information about formal test programs.